

Forest Pest Management

Pacific Southwest Region



Insect and Disease Conditions in Stand #500-2915 **Tahoe National Forest, Nevada City Ranger District**

(FPM Evaluation #NE00-13)

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Introduction

At the request of Gary Cline, Forester on the Nevada City Ranger District, Forest Pest Management (FPM) evaluated the insect and disease conditions in Stand #500-2915 on April 10, 2000. The stand is 48 acres in size, and located in the Pioneer Timber Sale that is being prepared under the Pioneer Environmental Analysis. Aggregates #1 and #3 were evaluated. Gary is preparing a silvicultural prescription for this stand, which will fulfill one of his requirements to become certified as a silviculturist in the USDA Forest Service. The purpose of this evaluation was to assess the condition of the trees with respect to insects and diseases and to provide Gary management alternatives for use in his silvicultural prescription.

Observations

Aggregate #1: This aggregate is approximately 39 acres in size and is stocked with ponderosa and sugar pine, Douglas fir, white fir and incense cedar. Tree health in aggregate #1 is generally good. However, the stand is overstocked. Conifer mortality occurred within the aggregate during the early 1990's. The mortality was associated with several years (1987-1993) of inadequate moisture levels, bark beetle attacks, and overstocking. Stress from crowding has resulted in a number of group-kills of young, mature ponderosa pine. Western pine beetle, *Dendroctonus brevicomis*, galleries were present on the dead pines. In addition, red turpentine

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beetle, *Dendroctonus valens*, attacks were common on some of the live pines also indicative of poor or declining individual tree health. This condition has resulted from past fire suppression, overstocked stands and, in the recent past, protracted drought periods. Regular recurring natural fire would have thinned the stand and kept most of the present understory (shrubs, conifers, and hardwoods) from becoming established and/or competing with the dominant conifers. These conditions have resulted in an increase in susceptibility to insects, pathogens, and stress, particularly during protracted drought periods.

Aggregate #3: This aggregate is approximately 5 acres in size and contains mostly young, mature white fir with a few ponderosa pine, incense cedar and black oak trees interspersed throughout. It appears that the conifers in Aggregate #3 gradually emerged through a dense shrub cover. Numerous openings are not stocked with trees because of the thick brush that was present during stand establishment. Green-leaf manzanita, whitethorn and chokecherry are common shrubs in the stand. Dying thickets of these shrubs occur in openings. Tree health is poor. White fir dieback, top kill and wind throw indicate that the trees are stressed. Examination of the roots and stumps suggest that annosus root disease, caused by the fungus *Heterobasidion annosum*, is present. The roots of many of the wind thrown white fir are decayed. The wood in some of the decayed roots exhibit a delamination along the growth rings and some of the decaying stumps have white rot. Fir engraver, *Scolytus ventralis*, is a common associate of the root diseased white fir trees. Primarily root disease and overstocking with trees and shrubs are factors contributing to the increase in susceptibility to this beetle.

Discussion (Aggregates 1 and 3)

Conifer mortality has occurred over the past decade in stand #500-2915. Mature ponderosa pine and all size classes of white fir have been affected. This mortality can be attributed to bark beetles, annosus root disease, stand conditions and environmental factors. It appears at this time, the primary agent associated with fir mortality is annosus root disease (aggregate #3).

Historically, the most significant widespread, weather-related effect on the vegetation has been conifer mortality associated with severe moisture stress. Conifer mortality tends to increase whenever winter precipitation is less than about 80% of normal. Trees stressed by inadequate moisture levels have their normal defense systems weakened to the point that they are highly susceptible to attack by bark, engraver and wood-boring beetles. Inadequate moisture levels combined with overstocked stands often leads to unacceptable levels of conifer mortality. The basal area of some groups within the stand exceeds 300 sq. ft/acre. This basal area may be maintained during periods of adequate moisture levels however during protracted drought periods some mortality will likely occur. Within the aggregate #1, the majority of the current mortality is in the large overstory pines. In some cases these trees cannot compete with the dense understory vegetation for limited resources and therefore become stressed and more susceptible to bark beetle attacks.

Bark and engraver beetle-related mortality occurs primarily in small groups with the pine bark beetles or as single trees scattered over a large area with the fir engraver. Successful attacks by the pine bark beetles (western and mountain pine beetles) result in tree mortality. Successful attacks

by the fir engraver (in white fir) can result in top-kill, branch-kill, patch-kill along the bole and/or whole tree mortality. In general, mortality occurs in overstocked stands, however during periods of protracted drought, mortality may be expected to occur throughout various stocking regimes. Effects and impacts resulting from bark beetles may include the following: direct tree mortality, openings that vary in size, less trees/acre, reduced canopy closure, increase in standing dead and down woody material, increase in fuel load, increase in decomposition and nutrient cycling, increase species diversity/decrease species diversity, increase in snags and cavity nesting opportunities and a change in species composition.

The importance or significance of these effects and impacts depends on their severity and extent and ultimately how they affect (positively and/or negatively) ecosystem structure and function (desired condition) and specific management goals and objectives. The effects of insects and pathogens can be used as an indicator of forest and ecosystem health.

The desired state of forest health, in relation to insects and pathogens, is the condition in which these agents do not threaten ecosystem structure and function and/or management goals and objectives. Forest health restoration activities provide an opportunity to restore the resistance and resilience of ecosystems to natural stresses such as drought and bark beetle attacks. Management alternatives such as thinning and reintroducing prescribed fire can increase the health and vigor of residual trees, enable the growth of trees adapted to the site and create or enhance tree species diversity, thus lowering susceptibility to damage caused by insects and pathogens.

Forest health restoration activities provide an opportunity to restore the resistance and resilience of ecosystems to natural stresses such as drought and bark beetle attacks. Management alternatives such as thinning can increase the health and vigor of residual trees, enable the growth of trees adapted to site and create/enhance tree species diversity, thus lowering their susceptibility to damage caused by insects and pathogens. Results of one thinning study are reported as an example to use in silvicultural prescriptions aimed at reducing/limiting future mortality. Priorities can be set based on the amount of departure that exists between the current ecosystem condition and future desired condition.

Management Alternatives

Aggregate #1:

(1) No action—Overstocked stands in general will tend to have higher levels of bark and engraver beetle-related mortality. The basal areas will continue to increase as the trees grow. The growth of understory trees and vegetation is competing with the old overstory conifers. Periodic droughts in California increase the probability, that some of the trees in the overstocked stands will be attacked by bark beetles. Although some mortality may be desired for snags, small openings, and for future down woody debris, the no action alternative will most likely result in unacceptable levels of mortality in the oldest conifers.

(2) Thinning Overstocked Stands—Management activities that promote tree health and vigor also reduce the susceptibility to successful bark beetle attack. Thinning is perhaps the most critical

silvicultural treatment available to restore and maintain forest health. Thinning from below reduces flammable fuels, creates growing space for trees, and can provide a receptive seedbed for conifer seed. Silvicultural prescriptions designed to reduce basal areas should result in lower levels of bark beetle-related mortality in the future. Mortality would continue to occur and fluctuate in response to the amount of available moisture, but at levels that, through time, would more closely approximate naturally occurring mortality. Thinning would result in a decrease in the need to enter stands to conduct salvage operations, a decrease in the amount of fuel loading, and a reduction in the number of hazard trees. Snags, down woody material, and nutrient cycling would occur at more natural levels. The improved growing conditions should result in reduced mortality of large diameter trees and an increase in mid-diameter trees available to grow into large diameter classes. Selecting for diversity of residual tree species during thinning is desired as bark beetles are fairly host-specific and diversity should guarantee that some trees will remain alive during elevated stress periods. Dependent upon slash treatment, there would be some level of risk of subsequent top-kill and/or whole tree mortality to residual conifers due to pine engravers that reproduce in green slash.

When harvesting conifers, treatment of the freshly cut stump surfaces with a registered borate compound (Sporax) will prevent infection the root systems with annosus root disease. Because no economically feasible procedure for directly suppressing the disease is available, prevention through the use of borate is the most efficient and economical method of reducing future impacts of *H. annosum*.

Aggregate #3:

(1) No action—The white fir trees in aggregate #3 will continue to be stressed by annosus root disease and drought, resulting in tree mortality and volume loss. White fir will continue to grow poorly and trees with roots weakened by root decay will blow over. Fir engraver beetles will continue to kill tops of stressed white fir trees. During prolonged periods of below normal precipitation, many of the stressed white fir will be killed by the fir engraver. Young white fir will eventually grow from seed in the existing or newly created openings. These young fir trees can become infected with annosus root disease if their roots contact infected roots. Some white fir may escape infection with *H. annosus* if their roots do not come in contact with infected roots. Vigorously growing white fir with annosus root disease can survive unless they become stressed by overcrowding and drought.

(2) Remove diseased fir and plant non-host conifers—It is impossible to know what white fir trees are infected with annosus root disease. Levels of infection are difficult to detect and determine because infection in true fir usually results in a heartrot with no above ground crown symptoms produced. Trees that appear healthy may or may not be infected. Uninfected fir can become infected in the future if their roots contact infected roots, or they may escape contact with infected roots and survive to maturity. Field observations suggest that vigorously growing white fir trees are able to regenerate root tissues faster than they are lost to the root disease. However, when the growth of true fir slows because of stand and/or site conditions, root development can decrease to a point where there is a net loss of wood in the roots. Under these conditions, the roots will eventually be unable to support a tree. Therefore, removal of slow growing fir and thinning of overstocked stands to increase tree vigor may reduce the impact of the disease, given that the

residual trees are capable of responding to release. For this reason some of the healthy appearing fir may be retained, if desired.

Use resistant species to revegetate active annosus centers. Maintaining host trees in a root disease center will also maintain annosus root disease. Douglas fir is also a host for the fir strain of annosus. Planting Douglas fir in aggregate #3 may help in maintaining annosus root disease. However, it is important to point out that Douglas fir in this area does not typically have insect-related mortality so it may be prudent to select for Douglas fir over white fir during thinning. By removing all the white fir and planting non-host conifers (ponderosa pine, sugar pine or incense cedar), *H. annosum* should eventually die out over a period of several decades or more.

Treatment of freshly cut stump surfaces created during thinning activities with sodium tetraborate decahydrate (Sporax) will reduce the probability of infection by *H. annosum*. In addition to being an aggressive colonizer of freshly cut stumps, *H. annosum* also acts as a wound parasite. Future losses to annosus root disease in the aggregate will be minimized by preventing fires that expose cambium when underburning for fuels reduction, and by reducing mechanical injuries during stand entries.

Insects and Pathogens

Fir Engraver, *Scolytus ventralis*

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater than 4 inches in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped firs and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without first killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality. Resin canals and pockets in the cortex of the bark are part of the tree's defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes that are often formed when bark beetles attack pine are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or all of the bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry a brown staining fungi, *Trichosporium symbioticum*, into the tree which causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those which have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality however attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Red Turpentine Beetle, *Dendroctonus valens*

The red turpentine beetle, *Dendroctonus valens*, occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are attracted by fresh pine resin and often attack wounded trees in campgrounds, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines. Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

Attacks can be minimized or prevented by avoiding soil compaction and injury to standing trees during logging or construction and also by insecticide application to high value trees.

Western pine beetle, *Dendroctonus brevicomis*

The western pine beetle, *Dendroctonus brevicomis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of this host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees

continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white, pitch tubes usually indicate that the attacks were not successful and that the tree will survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby apparently healthy trees and overwhelm them by sheer numbers.

Life Stages and Development

These beetles pass through the egg, larval, pupal and adult stages during a life-cycle that varies in length dependent primarily upon temperature. Adults bore a sinuous gallery pattern in the cambium and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem and then mine into the middle bark where they complete most of their development. Bluestain fungi introduced during successful attacks probably contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions Affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys initiated in the 1930's indicates that there were enormous losses attributed to western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Jeffrey pine beetle. Rather, observations indicate that emerging beetles leave the group kill to initiate new attacks elsewhere.

Under normal conditions the western pine beetle breeds in a few overmature trees, unhealthy trees, or in trees weakened by drought, stand conditions, or fires (Keen 1952). The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out or eject attacking beetles. But, when deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation or protracted drought periods; or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers, predaceous beetles and low winter temperatures are natural control agents.

Douglas fir tussock moth, *Orgyia pseudotsugata*

Although, no defoliation by Douglas-fir tussock moth (DFTM), *Orgyia pseudotsugata* (Lepidoptera: Lymantriidae) was detected, this stand is in an area that has been monitored by the early warning detection system for several years. Average trap catches have fluctuated over time. Table 1. shows the average trap catches for the plots on the Nevada City Range District. Outbreaks cause short and long-term changes in stand development. Both radial and height growth for trees are sharply reduced during and immediately following an outbreak (Mason & Wickman 1984). Growth reduction is proportional to the amount of defoliation and most pronounced in trees defoliated 50% or more (Wickman et. al. 1980). However, growth usually returns to pre-outbreak levels within 5 years and after 10 years may surpass pre-outbreak growth rates (Wickman 1978b). Enhanced growth appears to be the result of increased nutrient cycling, brought about by defoliation and the lower stocking levels resulting from tree mortality (Mason & Wickman 1984).

Conditions and habitats that are prone to DFTM outbreaks have been identified. Infestations often occur in seral stage communities and forested-grassland ecotones, where sites are marginal for the growth of fir, and except for fire exclusion and selective logging, are normally dominated by pine or are not forested (Wickman 1978a, Williams et. al. 1980). As mentioned previously, white fir is the preferred host species in California. Many mixed conifer stands have an unnaturally high component of white fir as a result of logging practices that selectively removed the more economically valuable pine species. The results of selective harvest systems and high-grade logging have increased stand hazard conditions to DFTM defoliation by favoring regeneration of host species (Stoszek 1978). Also, fire suppression policies have largely excluded fire from these stands. This encourages the less fire resistant and more shade tolerant white fir. These management practices have combined to increase availability of white fir foliage suitable for DFTM population increases and outbreaks.

Site and stand characteristics in areas where outbreaks have occurred provide further information about the habitat types that are prone to DFTM outbreaks. Wenz and his coworkers (1977 unpubl.) compared site and stand characteristics on 66 plots on the Modoc, Eldorado and Stanislaus National Forests where DFTM outbreaks were known to have occurred, to characteristics of 67 plots in the same general areas that had no records of outbreaks. They found that outbreaks occurred in stands located on ridgetops of upper slopes and on poorer sites. Stands where outbreaks had occurred also tended to have a lower stand density, particularly of white fir, less crown cover, shorter upper story trees, and less vertical diversity than stands without an outbreak history.

Annosus root disease (caused by *Heterobasidion annosum*)

Conks of annosus root disease were found by Gary Cline in two decayed white fir stumps in Aggregate #3. Since *H. annosum* is usually confined to the heartwood of true firs, any of the older white fir may be infected with no above ground symptoms evident. *H. annosum* is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. A few brush

species (*Arctostaphylos sp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all the National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in California. Current estimates are that the disease infests about 2 million acres of commercial forest land in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and in recreation areas, depletion of vegetative cover and increased probability of tree failure and hazard.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds or occasionally, through roots of stumps in the absence of surface colonization. From the point of infection, the fungus grows down into the roots and then spreads via root contact into the root systems of adjacent live trees, resulting in the formation of enlarging disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

H. annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of *H. annosum* have major differences in host specificity. All isolates of *H. annosum* from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir, Douglas fir and giant sequoia have been of the 'S' group. This host specificity is not apparent in isolates from stumps, with the 'S' group being recovered from both pine and true fir stumps. This data suggests that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

When cutting conifers in recreation areas, it is directed (R5 FSM 2303) to treat the freshly cut stump with Sporax, the borate compound that is registered to prevent *H. annosum* from entering healthy conifer roots through stumps. Conifer stumps 12 inches or greater in diameter should be treated with Sporax after chainsaw felling. When mechanical fellers are used which cut the stumps near the ground, the minimum diameter should be reduced to 8 inches.

Although surveys and studies have indicated the benefit of borating pine stumps, the efficacy of treating true fir stumps is less certain. Borate does reduce infection of true fir stumps, but treatment of stump surfaces will not prevent the entrance of *H. annosum* into the root systems of true fir stumps from adjacent infected trees, or entrance by other means. The pathogen can enter

true fir through mechanical wounds and fire scars, and true fir are often infected with the pathogen before stand entry.

Table 1. Mean Douglas-fir Tussock Moth Pheromone Trap Catches for Nevada City RD, 1980 - 1999.

Plot Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Diamond 1	0	0		0	11.2	12.6	2.8	1.8	0	0.2
Diamond 2	0.6	0.6		0	22.2	13.3	11.4	4	0.6	0
Diamond 3										
Sardine Spg	0	0.2		0.4	5.4	6.2	4.4	0.8	0.2	0
Skillman	0.2	0.2		0.6	17.2	6.2	1.2	6.8	1.2	0.8
Alpha Omega	0.2	0		0.8	5.6	3.4	0.6	0.6	0.4	1.6
Alpha Omega2										
Alpha Omega3										
Indian Spgs	0	0		0.6	14	5.8	1	4	1.2	5.8
White Cloud	0	0		0.2	14	2.5	0.4	1.8	0.8	2.6
Levey Ditch										
Steep Hollow										
Water Tank										
Deer Creek										
Snow Tent										
Cheery Hill										
Graniteville										
Rocky Glen										
Ceiling										
Bowman										
Fulda										
Monumental										
Burlington										

Plot Name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Diamond 1	0	7	0	0.2	0.4	4	72*	5.2	13.2	1.6
Diamond 2	0.4	10.6	0.8	0.2	4.6	10	16.2	7.8	14	6.6
Diamond 3					1	3	30.4	5	15.2	
Sardine Spg	0.2				2	3	40.8	3.8	7	
Skillman	0.4	11.2	2	0.2	4.4	10.6	34.2	8.8	9.4	
Alpha Omega	1.4	8	0.25							
Alpha Omega2			0	0.2						
Alpha Omega3			1	0.8	3.2	1	23.6	3.4	6	1.6
Indian Spgs	0	23.4	4.2	2.8	2.2	3.4	13.4	19.6	26	
White Cloud	0.4	7.8	2	1.4	5.4	28	47	23	30	23.4
Levey Ditch			0	0.6	1.4	0	1.6	3.4	1.8	1
Steep Hollow			0	0.6	4.6	5.8	21.8	5.4	26.6	
Water Tank			4	1.2						
Deer Creek										10
Snow Tent										3.3
Cheery Hill										3
Graniteville										4.4
Rocky Glen										1.4
Ceiling										1
Bowman									3	
Fulda									6.2	
Monumental										2.8
Burlington										12.2

*Bold numbers denote an average of >25 moths per trap for the plot.